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ABSTRACT

Volume I of this report summarizes an evaluation of eleven projects which were designed to test mechanisms for increasing the access of ethnic minority students to careers in science and technology. The goals of the evaluation were threefold: to document the experience of the several projects in order to make that experience available to future efforts, to weigh the potential of each project's intervention strategy for more general application, and to recommend both policy and administrative changes which would improve procedures for the evaluation of new experimental project proposals. Recorded in Volume I are overviews of the study's methodology, major findings, conclusions, and recommendations. Brief descriptions of each of the eleven projects are given, followed by a general discussion covering ways in which the projects could be improved upon in terms of management and evaluation. Flow patterns diagramming the typical educational experiences for different minority groups are included along with a review of recent minority science education intervention attempts. (DT)

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Volume I
Executive Summary

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ABSTRACT

During the early summers of 1974 and 1975, the National Science Foundation made grants to a total of 11 institutions for projects designed to test mechanisms for increasing the access of ethnic minority students to careers in science and technology. The Foundation's objective was to identify and demonstrate the effectiveness of models which had a potential for broader use. The American Institutes for Research (AIR) became a party to this effort in June of 1975 when it was selected by NSF to act as the "third party" evaluator of the projects.

The goals of the evaluation were threefold: to document the experience of the several projects in order to make that experience available to future efforts, to weigh the potential of each project's intervention strategy for more general application, and to recommend to NSF both policy and administrative changes which would improve procedures for the evaluation of new expermental project proposals.

AIR began its work in July of 1975 with two parallel efforts. One involved the attempt to provide a context for the individual intervention efforts by examining the experience of a wide variety of other projects and collecting background information related to the typical educational flow experience of minority students. The other effort was the documentation of the individual projects, which included visits to the project sites and extensive interviewing of both staff and participants.

AIR's report was submitted to NSF in November of 1976. It included detailed case studies of the experience of eight projects. (The other three were multi-year efforts and the report will be revised in October of 1977 when those have been completed.) The report also brought together information from a wide variety of sources related to the educational experience of White Americans, Black Americans, Mexican Americans, native Americans, and mainland Puerto Ricans. "Typical Education Flow Pattern" diagrams summarized the various groups' experience from first grade through graduate school and were utilized to compare retention rates among the five groups at various stages of the education flow. A discussion of the major deviations in experience was included along with suggested priorities for remediation.

On the basis of the experience of the 11 projects studied, it was apparent that proposers of new projects need to pay special attention to t detailing of a credible evaluation plan designed to survive potential proj implementation difficulties, they should investigate the present state-of-the-art of the techniques being considered for use in implementing interve strategies, they should make reasoned decisions regarding the choice of project participants and resist compromises with practicality which would alter the type of participant actually selected, and they need to consider the potential consequences of project failure to all those involved.

The policy recommendations which AIR made to the Foundation dealt wit the advisability of expanding experimental programming efforts in the mino ties area, the need to increase the participation of minority researchers institutions in the search for new intervention strategies, and the advisa bility of NSF assuming more of a role as a resource for the purpose of rai the quality of potential projects.

AIR also made a number of administrative recommendations which could serve to improve the technical level of proposals and increase the probability of success of those experimental projects actually funded.

PREFACE

This final report "An Analysis of Supported Projects to Test Methods for Increasing the Access of Ethnic Minority Students to Careers in Science and Technology," is divided into two volumes as follows:

Volume I: Executive Summary--provides a brief overview of the study's methodology, major findings, conclusions, and recommendations.

Volume II: Technical Report--provides a full presentation of the study's background, goals, methodology, conclusions, and recommendations. Also included are full descriptions of 11 experimental projects designed to improve the access of minority students to science-related courses of study and a discussion of many other recent attempts to accomplish the same ends.

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1. INTRODUCTION

Background and Purpose of the Study

In the late summer of 1973 the National Science Foundation announced plans to accept proposals for projects to test mechanisms designed to increase the participation of ethnic minority students in careers in science and technology. Responses to that announcement resulted, in late May and early June 1974, in the funding of 10 projects which planned to test various intervention strategies for improving the flow of minority students along channels which were likely to lead to science/engineering careers. The following year, grant money was again available and an eleventh project was funded. The Foundation's objective was to encourage the identification and demonstration of effective models which had a potential for broader use with minority students. The ultimate goals of the group of studies were to provide the educational community with a set of proven cost-effective mechanisms, and to provide the Foundation with guidance for future program efforts.

As a further step toward achieving its goals, the National Science Foundation contracted with the American Institutes for Research to act as the "third party" evaluator of the Foundation-sponsored projects. The objectives of the assessment were threefold:

--To provide a description of each project, covering goals, outcomes, procedures, applicants, participants, costs, etc., with the intent of assembling the experience of the various projects and making the benefits of that experience available to potential future projects.

--To carry out an analysis of the set of projects as a whole, specifically focusing on the potential of each project's intervention strategy for more general application.

--To make policy and administrative recommendations regarding future activities in this field, including improved procedures for evaluating new proposals for experimental projects.

Work was begun by AIR in July of 1975 along two tracks. The first track was the documentation of the individual projects, which ultimately involved visits to the project sites and extensive interviewing of both staff and participants. The second track involved efforts to provide a context against which the individual NSF-funded projects could be viewed, by examining the experience of a wide variety of other projects and collecting background information related to general educational flow problems of minority students. A final report was submitted to NSF in November of 1976[1] and a revision will be submitted in October, 1977, which will include complete analyses of three multi-year projects presently still ongoing.

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[1] J. B. Aronson, *An Analysis of Supported Projects to Test Methods for Increasing the Access of Ethnic Minority Students to Careers in Science and Technology*. Washington, D. C.: American Institutes for Research, 1976. Unless otherwise noted, all subsequent footnotes refer to the section of the full report which is being summarized.

Operational Constraints

There were a number of constraints on this study which, necessarily, had an effect on the final outcome. While it is believed that the problems generated by those constraints have been largely overcome, the discussion and recommendations which follow in the body of this report must be understood in terms of the context within which AIR was working.

Constraints on Project Documentation

Of the original 10 project grants made in May of 1974, five were for 13 months or less, two were due to terminate in October, 1975 after 17 mont while three were to be carried out over a period of two and one-half to th years. Thus, when AIR entered the picture in July of 1975, nearly all the projects had either been completed or were just winding up their activities Most of the AIR field visits were carried out from October through the earl part of December of that year, but by that time several key people were no longer associated with the projects and, often, the participants had dispersed very widely.

A second relevant factor is the extreme variability of methodology utilized by the individual projects: One attempted to impact on 20 student while another had its focus on the science classes at 17 different large high schools; a third project sought to affect the ultimate career choice of fifth- and sixth-grade youngsters, while a fourth dealt with community college pre-freshmen with an already expressed interest in engineering. Along the time dimension, planned participant contact with the projects ranged from three hours to three years.

Constraints on Background Information for Flow Pattern Construction

In trying to construct a general educational context for each of the minority groups involved in the 11 projects being studied, a number of difficulties were encountered, the greatest one being that certain desired information is simply not collected by any agency or any interest group. The accumulation of racial education data has been a very recent phenomenon and, while individual institutions have gathered such information over many years, it is only since about 1970 that EEOC requirements have prompted its accumulation on a national level. Further, minority groups other than Blacks have had a difficult time gaining representation as independent entities in national surveys and the available data reflect that. Some studies report information for "White Students," "Black Students," and "Others"; while others identify subgroups as "White," "Black," and "Spanish Surname" without differentiating Americans of Mexican heritage from those with a Puerto Rican or other Spanish background. The data for native American students posed special problems because the Bureau of Indian Affairs of the Department of Interior and the Office of Education of the Department of Health, Education and Welfare utilize different criteria for defining who a "native American." These two definitions result in strikingly different estimates of the total number of native Americans in the United States.

Despite these internal inconsistencies, an extreme effort has been ma to gather and integrate the most recent and best information from a wide variety of both published and unpublished sources.

Caveats

This study brushes the fringes of several important areas which need considerable further elucidation. However, the scope of the present study was limited by time and by intent to the issues dealt with by the 11 research grants and to the elements in the context in which they operated. Thus, while this study has been concerned with documenting the education experience of minority groups, it has not attempted to ascribe causes of difficulties minority students may have faced nor is it able to propose remedies.

The special problems women have had in entering science and technological careers are not a subject of this study even though the proportion of minority women in those careers is much smaller than the proportion of non-minority women. None of the projects being evaluated addressed itself to sex differences and, though women were heavily represented in the programs at nearly all of the 11 project sites, no separate records were kept by any of the projects.

A word must be inserted here about the use of ethnic labels in this report. The term "Black" poses little difficulty as it is widely accepted and does not overlap significantly with other minority groups. The terms "native American" and "American Indian" seem to be used interchangeably in the literature though the latter term seems to be giving way to the former in the more recently published documents. The Spanish ethnic groups pose more of a problem. The term "Spanish American" is not much used now, having been replaced in large part by the equally non-descriptive "Spanish Surname," under which title much data is still subsumed. Quite recently, the category has begun to be differentiated into "Mexican American/Chicano," "Puerto Rican American" (or more simply, just "Puerto Rican"), and "other Spanish speaking." This last category contains about one-third of the individuals included under the more general rubric, but their problems are not addressed in this report. "Mexican American" seems to be preferred over "Chicano," since many of those people object to being called "Chicanos" even though the latter term both predates the former in popular usage and is preferred among the younger members of the group. The term "Puerto Rican" will be used in this paper but will refer in this context to those people of Puerto Rican background presently living on the U. S. mainland.

There are special semantic difficulties when the accepted racial/ethnic designations are used in a comparative sense. For example, the majority group in the United States is termed "White" when compared with Black, whereas it is called "Anglo" when it is compared with Mexican American people. Too, Puerto Ricans are also mostly "White" though a few are "Black," and there seems little logic in differentiating Mexican Americans from "native" Americans on the implied basis of length of ancestral settlement in North America. Nevertheless, these terms will have to be used despite their imprecision because a more rational system of reference has not yet been evolved.

2. RECOMMENDATIONS[2]

Based on the totality of the experience of the individual projects, with the strategies they attempted to execute, and with their relationship to the National Science Foundation, the following recommendations are made:

NSF Policy Recommendations

- *The National Science Foundation should continue with an expanded experimental programming effort in the minorities area provided that project quality can be raised to the point where answers to a number of pressing questions can legitimately be expected to be answered.* The experience of the 11 projects in this study and review of the descriptions of science education projects for minority students assembled by the Office of Opportunity in Science of the American Association for the Advancement of Science make it clear that very little is presently known about the mechanisms which are useful for improving the access of minorities to science careers. A large part of the problem up to now has been that most intervention attempts have been carried out without a proper evaluation of their accomplishments. NSF, by funding an improved quality of project (specific recommendations for project improvement are given below), could make a signal contribution to the state-of-the-art.

- *If minority funding of the present variety is to be continued, NSF should broaden substantially its dissemination of funding availability information.* The present program effort seems not to have attracted many proposals from minority researchers. Indeed, of the four minority group project directors involved in the present series, three learned of NSF's minority programming purely by chance. Further, two of the 11 projects would appear to have been marginal prospects for funding under this particular category. The Stanford University project breaks important ground but would not seem to be designed "to test mechanisms . . . (for) increasing the flow of ethnic minority students into careers in science." The University of Michigan project received funding for a rerun of a successful program it had initiated the previous year. This is not meant to detract in any way from the work that was done on these projects, it is merely to underscore what appears to be a very weak response to the NSF program announcement from the smaller colleges, from institutions which are oriented primarily toward minority students, and from minority researchers, wherever they may be located. In industry, equal opportunity employers have found new and effective ways of advertising jobs so that minority group members have a much greater chance of competing successfully. The National Science Foundation should take the same stance with regard to its own programming. Modes of information dissemination aimed specifically at minority channels of communication could be expected to generate a larger number of potentially fruitful project ideas.

[2] This section fully reproduces the Recommendations found on pp. 23-27 of of the technical report.

- Whether or not minorities are involved, if this general type of project is going to be encouraged, *NSF should allow itself to move into a more cooperative relationship with individual projects starting at an early stage in the funding process.* Judging by the 11 projects reviewed in this study, NSF's sink-or-swim stance of non-involvement with the projects it funds allows many good ideas to go under for reasons unrelated to the theoretical considerations being tested. While the grant relationship prevents NSF from active participation in a project, the Foundation can and should make itself more of a resource in a variety of ways. Several are suggested below under "Administrative Recommendations."

Administrative Recommendations

- *To help reduce the number of proposals with good ideas but weak execution, NSF should develop a kit of explanatory materials which would be available to anyone upon request and sent automatically to those whose pre-proposal ideas are deemed worthy of pursuit.* In the minorities area, NSF is dealing with a population of proposers who are not necessarily experienced planners, budgeters, or researchers. But they are dedicated and they are fully familiar with the strengths and limitations of their potential project participants. A kit of materials which clearly and completely describes the elements of a successful proposal and which also provides suggested formats for budgets, allocation of personnel resources, evaluation strategies for various circumstances, and the like, would be of enormous benefit to those people.

- *NSF should provide technical assistance to the authors of promising pre-proposal ideas where that is needed in order to produce a fully articulated final proposal for NSF's consideration.* Many of the difficulties encountered in the execution of the 11 projects included in this evaluation could have been anticipated had some of the standard project planning mechanisms been employed by the project originators. It would be of great benefit to the projects actually funded and, no doubt, cost-effective in terms of project success, if NSF could supply an experienced project planner to work with a proposer in the elaboration of the proposer's basic ideas. Where a proposal seems to have few difficulties, supplementary work could be done at low cost by telephone, but where the proposal idea seems to be fruitful but ill-explained, it might be necessary for an advisor to make a brief site visit of one or two days for working meetings. The National Institutes for Mental Health, Center for Minority Group Mental Health Programs presently has such a program in operation. They arranged a pool of consultants with a variety of expertise and assign them to proposals which fall in areas of targeted priority. The consultants can be utilized by both minority and non-minority proposers, but special efforts have been made to advertise their availability through minority newsletters and professional organizations. As a result of this effort, NIMH reports that the quality of funded programs has increased.

- *NSF should improve materially the amount of communication between itself and potential grantees so that appropriate planning can be carried out by them and realistic expectations maintained.* The difficulty of obtaining information about the status of their proposal was a constant irritant to nearly every project director contacted in this study. At most of the project sites, AIR was told specifically that funding had been expected much earlier in the year that it arrived. It is not clear how the project directors reached that conclusion, since there does not seem to have been any communication from NSF regarding the approximate date of expected funding or the length of time NSF needed to process grant requests. Nevertheless, important decisions were made on the basis of supposition and belief which could not be clarified with NSF. It was especially exasperating to some projects when their first knowledge of NSF funding came from sources outside of the Foundation and then project start-up was further delayed when official notification of funding became caught up in the bureaucratic tangle of their own institutions. As pointed out in the text of this report, many projects were injured by this sequence of events; one or two, perhaps fatally.

The above recommendations concern the general stance of NSF vis-a-vis the individual projects it funds. Below are several recommendations for administrative changes which will serve to raise the overall quality of the projects considered for funding.

- *NSF should insist on high-quality proposals which meet stringent criteria of completeness and which effectively treat the several critical project areas.* Planning, participant selection, evaluation, and consequences of project failure are all essential elements in a proposal of this sort and none should be slighted. Among the 11 projects already funded, NSF made decisions regarding several on the basis of strong but incomplete proposals. As mentioned elsewhere, evaluation was often weak, but once NSF passed positive judgement on the overall proposal, there was not much new thought given to the individual elements.

- *NSF should include an evaluation specialist on every peer review committee.* An individual with field-implementation experience would be a significant asset to the review committee and his or her presence would undoubtedly result in an overall improvement of project quality.

- *NSF should establish a mechanism for conditional approval of project proposals pending receipt of supplementary materials designed to eradicate specific deficiencies in the original proposal.* Such conditional acceptance would make it largely unnecessary to proceed with the funding of a substantially acceptable project which, nevertheless, includes elements which are obscure. Among the 11 projects in this study, the greatest single difficulty was inadequate planning for evaluation of the project's impact. The proposers were all intelligent people with good ideas, but they lacked experience with impact assessment. These people would appear to be typical of the population of proposers

NSF would be dealing with in program areas of this sort and it seems a bit unrealistic for NSF to demand evaluation sophistication of people who are not social scientists by profession. On the other hand, a project which lacks evaluation is of very little use toward furthering the understanding of effective intervention strategies. A conditional acceptance would let the proposer know that the project is being seriously considered for funding and would allow the proposer to repair weak sections in order to meet acceptance criteria. This mechanism would result in the strengthening of many projects and thus increase their probability of successful completion.

- *NSF should set aside some portion of its grant funds for contingency awards.* This would serve two purposes. Since NSF's policy is to fund innovation but not implementation, and since proposers of projects are interested in implementation as well as innovation, some small additional funding for the further exploration of promising techniques would serve the purpose of bridging a time period during which the project director could search for local support for carrying out his or her ideas. Under the present circumstances, this is very difficult because the typical year or 18-month funding period is usually too brief a time to gain a sense of the quality of the innovative technique, develop new ideas, and apply for renewed funding from other sources in time for project continuity to be maintained. The second benefit of contingency funding is that NSF would be able to pursue interesting approaches by providing support for follow-up studies and longer-term evaluations.

The totality of the project experience and the general state-of-the-art in the area of minority education suggests several directions for new programming which NSF might pursue:

1. The Foundation should consider coordinating the funding of, or actually funding, a major high-level national effort to acquire and maintain a head count, on a grade-by-grade basis, of students from all minority groups which have special education problems, either nationally or regionally. This would provide a basis for policy-making, for the expenditure of funds, and the building of programs to facilitate the participation of those minority students in careers in science and technology. There is a long litany of basic information about minority students which is needed but unavailable: The education problems of native Americans in urban settings are largely undocumented; the extent to which Mexican American and Puerto Rican students are behind their age-grade can only be guessed at using grouped census data now many years old; the shifts in popularity of community colleges and four-year institutions have great implications for the training of minority students, but few records beyond the gross numbers involved seem to be kept; almost nothing is known about the degree to which minority students are electing to major in science or engineering courses during their college careers, and still less is known about

the relative success of those science majors as they progress through baccalaureate and graduate training; minorities' experience in community colleges, their rates of successful completion, and their rates of transfer to four-year institutions are all a mystery. Light in any of these dark corners would be welcome; a major effort would be of immeasurable assistance.

2. NSF should find ways of emphasizing intermediate science careers during a student's high school years in order to alleviate the all-or-none concept of science which is very generally held by minority and non-minority students alike. Virtually all science information available (and virtually the sole focus of the 11 projects in this study) relates to the top science careers--the physicist, chemist, biologist, engineer, etc.--rather than to the middle-level positions, such as lab technicians, jobs in the health fields, and others. A lack of role models is often identified as a contributing factor to minority group students' relatively small representation in the science fields. Emphasis on intermediate careers could well encourage many more students to pursue science interests and thus rapidly increase the number of those who can call themselves scientists.

3. NSF should explore the effect of early and substantial career counseling on the science choices of students over the long term. A large proportion of students come to a decision about career choice before entering high school; minority students seem to decide at a later point, but this may be due partly to their relative lack of career information. For the latter, by the time choices are made, it is often too late to take the required science and mathematics courses necessary to pursue a technical interest.

4. The National Science Foundation should explore the role of community colleges in the preparation of science students. Large proportions of minority students attend junior or community colleges but very little is known of their fate except that most don't finish and relatively few (compared with four-year institutions) elect science as an academic major. The community college is playing an increasingly major role in education and it seems essential to know what part is taken by its science departments.

5. While some longitudinal research has been carried out by NSF and other agencies, additional work in this area is very much needed. Very little is known about how science choices are made by minority students and there has been virtually no longitudinal follow-up of participants in specialized programs of a nature similar to those in this study.

3. METHODOLOGY

This study was essentially analytic but it also included some investigative and evaluative elements. The latter raised a major initial concern: The project grants from NSF had contained no admonition that the work was to be examined by an outside evaluator, so it seemed likely that directors would be disturbed by the prospect, since internal record-keeping and other documentation had not been carried out by them with an eye toward subsequent critique. Thus, one of the earliest of AIR's objectives was to create the understanding with the projects that AIR's efforts were oriented toward the future rather than toward the past; that is, that the details of each project were to be examined from the point of view of how that experience could help NSF and future projects.

The following steps were carried out as this study was conducted:[3]

Task I--Project Familiarization

A meeting was held at the National Science Foundation between the AIR Study Director and members of his staff, and personnel from the NSF Office of Experimental Projects and Programs. Documents from each of the 11 project files were obtained and examined.

A meeting was also held between AIR study personnel and consultants from both within and outside of AIR to review the 11 individual project plans, to outline sources of information related to the issues addressed in the projects (e.g., education problems of native Americans, experience with bilingual instruction, impact assessment in the educational setting, etc.), and to raise possible ethnic sensitivities and concerns of those involved in the individual projects as either staff or participants.

Task II--Establishment of Cooperative Contact with Individual Project Directors

NSF had called a late August (1975) meeting in Washington of all of the Directors of the individual projects and studies. In early August, a letter was sent by AIR to each of the Project Directors outlining the scope and intent of the "third party" assessment and was followed up about 10 days later with a telephone call to ascertain that the letter had been received, that there was an understanding of the basic purposes of the assessment, and to request that copies of project documents not already sent to NSF be brought to the Directors' meeting for AIR's use so that site visit planning could be made more explicit.

At an early point during the two-day Project Directors' meeting, the AIR Study Director made a formal presentation of the goals and plans of the assessment with emphasis on the potential application of the strategies developed by the experimental projects.

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[3] See pp. 7-14 of the full report.

At this juncture in the conduct of the study, work began to be more clearly divided between project information acquisition (designated below by the letter "A") and data acquisition for the "Typical Education Flow Patterns" being constructed to provide a context for the strategies being experimented with by the projects ("B" tasks).

PROJECT-RELATED TASKS

Task III-A--Determination of Essential Project Elements

The study's advisors and consultants were again convened and a draft "Project Information Checklist" submitted to them for their comments. This document was intended for use as reference during the site visits.

Task IV-A--Site Visits

Since nearly all of the projects had been in operation for a year and several had already been completed by the time AIR began its efforts, it was decided to try to arrange all of the travel so as to arrive at a site after the final data collection but before the report was written. AIR wanted to avoid interfering with evaluation efforts by interviewing participants before posttesting was carried out, but felt that the project review necessary for AIR's benefit could be useful for the task of preparing the final report.

A two-person team began site visits in early October (1975) and planned to conduct extensive interviews with all persons associated with the project: administrative personnel, project staff, project participants, and individuals from outside the project who had had an impact on it. The object was to get as complete a picture as possible of the project's history and execution from various points of view.

Task V-A--Construction of Time-Lines and Milestone Records

The information gained from the site visit interviews and from the project documentation was used as source material to construct time-lines and to evolve a list of project milestones. In several cases where inconsistencies existed or there seemed to be gaps in the information, individual project personnel were telephoned and the problems resolved. As could be expected, some projects progressed rather uneventfully from beginning to end while others encountered a large variety of difficulties at many points along the way. Those difficulties, and the attempts to resolve them, are a primary focus of this study.

Task VI-A--Acquisition of Late-Maturing Data, Etc.

During the site visits, wherever it was appropriate, arrangements were made for new data and reports to be sent to AIR as they were produced by the projects so that the case studies could present a complete picture.

FLOW PATTERN-RELATED TASKS

Task III-B--Determination of Critical Decision Points During the Course of Science/Engineering Education

The meeting of advisors and consultants described in Task II-A also considered the question of which choice-points in the education process of minority students were the crucial ones for inclusion in the flow diagram. That choice was tempered by the realities of information availability as it was then known to exist.

Task IV-B--Accumulation of Minority Group Education Data

Utilizing leads supplied the project by its advisors and consultants as a starting point, AIR project personnel contacted education specialists from a large variety of special interest groups and government agencies, both in the Washington area and around the country. Several problems with the available data arose immediately and, though special efforts were aimed at resolving them, some were never completely dispelled. For example, the post-high school academic experience of native American students is not very precisely known because separate statistics are often not kept for them and because they have a very high rate of dropout and drop-in.

Task V-B--Revision of the Typical Education Flow Pattern Diagrams

An attempt was made to collect information related to each of the originally identified critical steps in the education process for every minority group involved in this study, but it became apparent that there simply was not enough information available about some of those stages to allow their inclusion in a sequential diagram. In a couple of major ways and in other minor ways the original plan for the elaboration of the Typical Education Flow Diagrams was changed to meet the realities of available information.

At this point in the temporal sequencing of the study, the two efforts joined.

Task VII--Integration of Other Studies Related to the Participation of Minorities in Science/Engineering Careers

Information was collected about a large number of other studies similar to the NSF-funded projects being assessed here in an effort to provide further context for the NSF projects and additional information related to the kinds of intervention strategies which seem to have promise for wider application.

4. CASE STUDY SUMMARIES

TEXAS A. & I. UNIVERSITY

"Developing Science Career Interest in Bilingual, Mexican-American Elementary Students"

June 1, 1975 - May 31, 1976

Respondents: Project Director, Co-Director, both Instructors, and 13 of 17 Participants

Brief Description

This experimental project was designed to increase the interest in careers in science of upper elementary Mexican-American students by stressing the development of bilingual science teachers for the 5th and 6th grades. Teachers in the project were given training in a summer workshop to increase their knowledge of general science, to develop strategies to teach science bilingually, and to increase their awareness of career opportunities in science. In-service training throughout the following year was designed to provide continued improvement of bilingual science-teaching strategies, as well as for the development of the counseling skills required to help inform minority students about the potential of careers in science.

Participant Selection

By the time that news of the funding of the project was officially received at Texas A & I., only a week remained before the public schools closed for the summer. The Project Director knew that nearly all of the teachers would already have had summer commitments, so he initiated a search for participants which was designed to recapture the same type of teacher who might have applied for the program, had funding come earlier: Information about the summer program was telephoned to the principals of each of the elementary and middle schools in the area which had a bilingual program or a large Spanish-speaking attendance; two special programs at the University had many more applicants than space, so the rejection lists were obtained and individuals named were sent descriptive material along with NSF project application forms; and recruiting was carried out in the University education classes during the first summer session with the expectation that there were many teachers taking courses who had not yet committed themselves for the second session when the NSF program was to take place.

The recruiting effort resulted in 27 applications of which 20 were accepted. (Rejected applications were from individuals who taught students below the fifth grade level or who had few bilingual students.) Of the 20, three people dropped the course almost immediately for reasons not associated with the project and one additional person was enrolled late.

"Case Study -- Texas A & I University," pp. 33-45. p. 41.

Programming Activities[6]

During the summer workshop there was great emphasis on the science resources available to the teachers, such as science materials in Spanish which could be borrowed from the Texas A. & I. Bilingual Library, resources provided by the state (including a Live Materials Center which could supply fish and small animals), and the major national science curriculum centers and publishers. In addition, the participants were taught how to perform basic science experiments in the classroom with commonly-found materials, how to construct simple teaching aids and class projects (such as milk-carton periscopes), and were taken on a number of field trips which they could later arrange for their own classes to take.

The bilingual education inputs to the project turned out to be fewer than had been planned. Three sessions focused on the language difficulties faced by bilingual students with special emphasis on those structural aspects of English and Spanish which cause the children the most difficulty. A number of rules-of-thumb were presented for converting English words to Spanish words and the participant group, itself, was used as a resource by dividing it into subgroups which then recorded both English and Spanish taped commentary for the slide shows produced by the participants as a class project.

The in-service training during the school year was devoted primarily to the sharing of experiences as the participants tried out things they had learned. There were also discussions about the counseling of bilingual students and the further refinement of bilingual science activities based on the students' needs.

Program Evaluation[7]

At the beginning of the public school year in the fall of 1975, 20 "control" upper-elementary science teachers were selected from within the same school districts the project participants had come from. The evaluation instruments were of two types: an interest inventory and a general achievement test in science, the latter including both commercial and locally written items. Both measures were administered in late September of 1975 to nearly 1,000 students of the teacher participants and their counterparts in the control group. The measures were administered again in early May of 1976 just prior to the closing of schools for the summer.

As of this writing, the results of the paper-and-pencil measures have not yet been tabulated. However, there are other indicators that the project is achieving many of its goals. The interest of the teacher participants was maintained throughout the year with virtually no absenteeism from either the summer workshop sessions or the in-service training during the school year. Though school resources of the participants were often very limited, the teachers all found ways to take their classes on science-related trips and showed initiative in providing science experiences for their students both during and after school.

[6] p. 41.
[7] p. 43.

All of the teacher participants interviewed were enthusiastic about their experiences in class during the school year. Two said that the in-service portion of the project had provided them with key encouragement to try new things. Nearly all of them had developed additional ideas for the following school year and all of them said that their teaching ability had been greatly improved by participation in the project.

Summary Comment

It seems evident that the quality of science instruction experienced by the students of the teacher participants in the Texas A. & I. project was much improved over that which they would have experienced had their teachers not been involved with the program. It cannot be known for several more years whether or not an increased number of those students opt for science careers, but it seems inevitable that they will have a better understanding of and appreciation for science. It is certain that the teacher's outlook toward science was materially changed as was the enthusiasm and methodology with which they taught it.

STANFORD UNIVERSITY[a]

"Curriculum Variables in Mathematics Learning"

September 1, 1974 - August 31, 1975

Respondents: Project Director, Coordinator, 4 Research Staff, 11 of 13 cooperating school personnel, 12 of many student participants

NOTE: THE STANFORD UNIVERSITY EFFORT WAS AIMED AT FURTHERING KNOWLEDGE ABOUT THE MECHANISMS OF LEARNING MATHEMATICS AND INVOLVED NO ATTEMPT AT ANY INTERVENTION STRATEGY FOR INCREASING THE PARTICIPATION OF MINORITIES IN SCIENCE. IT WAS FUNDED BY NSF AS A STUDY, RATHER THAN A PROJECT, AND WOULD NOT HAVE BEEN INCLUDED IN THIS EVALUATION EXCEPT FOR ITS DIRECT CONTACT WITH MINORITY STUDENTS. THE WORK WILL NOT BE DISCUSSED IN THE SAME TERMS AS THE 10 PROJECTS BECAUSE THAT WOULD DO A MAJOR DISSERVICE TO THE TECHNICAL ACCOMPLISHMENTS OF THE EFFORT. RATHER, THE PROJECT WORK WILL BE DESCRIBED BRIEFLY AND WITHOUT CRITICAL COMMENT.

This project was designed to test the effect of a single mathematics curriculum variable on the learning of Anglo and Chicano students. For each of four short studies, specific curriculum variables were selected, programmed units and criteria tests developed, a battery of pretests selected, classes selected and pretested, and the results subjected to multivariate analyses of covariance, etc. The effort was a continuation of a years-long program of research carried out by the School Mathematics Study Group at Stanford. It had been observed that understanding of the cognitive processes involved in the learning of mathematics was weak for

[a] "Case Study -- Stanford University," pp. 47-54.

Anglo students and almost nonexistent for Chicano students. However, what little was known clearly indicated that the learning processes for the two groups were quite different.

Participants[9]

Individual schools were identified on the basis of the education level (elementary, junior, or senior high school) and the approximate ethnic mix desired by the researchers. Generally, entire classes were used, but in the studies which involved reading ability, all students who were in the English as a Second Language (ESL) program were eliminated from participation due to possible reading difficulties.

At the three schools chosen, the proportion of Mexican American students ranged from 44% to 83%. Five 5th- and 6th-grade mathematics classes were utilized in November and December, 1974; 11 7th- and 8th-grade mathematics classes were involved in January of 1975 and eight 7th-grade mathematics classes were included in the study conducted in June of 1975.

Programming Activities[10]

Four separate studies were conducted during the period covered by the NSF grant. The first two (conducted in November-December of 1974) involved 5th- and 6th-grade Mexican American students. The first of these efforts tested the effect of a review of prerequisite skills and concepts on the learning of a topic in mathematics. The second study at Washington Elementary School involved a special analysis of the results of the first study. It investigated two alternate scoring methods for one of the measures and did not require the further testing of any students.

The third study compared content structure and cognitive structure in Chicano students' learning of mathematical probability topics. It was carried out in January of 1975 with 11 7th- and 8th-grade mathematics classes at Burnette Jr. High School in San Jose.

The fourth study was carried out at Hoover Junior High School in San Jose in June of 1975. It investigated the effect on Mexican-American students of pretraining on parallel test items before the administration of a mathematics predictor test. Eight 7th-grade classes were involved.

For each of these studies the classroom pattern was similar The first two days were devoted to the administration of pretests and the third was used to give the students practice with the programmed text format. Then, the students spent the next several days working on the instructional material, each proceeding at his or her own rate of speed, and post-measures were taken as they finished their work. The typical involvement of the students was for one hour each day for 10 school days.

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[9] p. 52.
[10] p. 52.

Results

The result of this series of efforts was a clearer understanding of several elemental issues related to the effect of cultural background on the ways students have learned to learn. Technical reports linking this work with the earlier work of the Stanford Mathematics Education Study Group and other researchers have been published as SMESG Working Papers and are available from Professor Begle's office.

MICHIGAN STATE UNIVERSITY[11]

"Evaluation and Comparison of Methods of Increasing Science Career Awareness"

May 15, 1974 - October 31, 1975

Respondents: Project Director, Project Coordinator, Ex-Project Coordinator, Film Director, 5 of 19 School Coordinators, 2 associated non-project personnel

Brief Description

Four specific methods of increasing science career awareness among minority junior high school students were to be compared and evaluated: a film of between 15 and 20 minutes in length, a slide show in conjunction with the visit of a minority scientist, television commercials aimed at the students' parents, and career guidance seminars for junior high school counselors.

Thirty rural and urban junior high schools in Michigan of varying economic and educational achievement levels were chosen as test sites. A science career awareness questionnaire administered to the participating students, plus enrollments in ninth-grade science and mathematics courses were to be measures of the level of science career awareness among participants before and after exposure to one of the four test methods. It was also planned to correlate social, economic, and educational data about the participants with the responses.

Staff Selection[12]

The method for selecting the coordinators at the various participating schools was not spelled out in the proposal. Interviews with some of them and with project management personnel indicate that this selection was left up to the school principals. In many cases, teachers who were solicited to participate were interested in, and enthusiastic about, the project. However, in other cases, the principal assigned the duty to an individual against that person's wishes. The result was a very uneven level of cooperation from school to school.

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[11] "Case Study -- Michigan State University," pp. 55-66.
[12] p. 61.

Participant Selection[13]

Though the proposal does not specify how the student participants would be selected, five school coordinators who were interviewed each explained how the selection took place at his or her school. It is clear from those reports that firm project control over the student selection process was lacking, since the participants varied considerably in the strength of their science background and their commitment to science courses. Another participant problem was that no concerted effort was made to reconvene the original groups for the post-measure administration. The result was a loss of 25% to 50% of the participant population in some schools.

Programming Activities[14]

From the point of view of the participating students, there was one dominant program activity: the pre- and post-questionnaires they were asked to fill out. Student exposure to the career awareness inputs varied greatly from one subgroup to the next. Two of the four coordinators who attended the counselor conference were interviewed and both said that they had personally benefited greatly from the two-day experience. However, it is questionable whether the student participants in their schools were impacted at all, as no special effort was made to counsel them. The television spot advertisements were directed at the parents rather than the students and there was no mechanism for determining whether or not the students viewed any of them. The original intent had been to have a minority scientist present the specially produced movie and to conduct a question-and-answer period following the 15-minute showing, but that did not always work out. One coordinator told the interviewer that she showed the film and then attempted to establish a connection between the film and science careers during the question period which followed. She said that she felt it would have been more effective had someone in the science field presented the film. No further project-related activities were scheduled between the time the film was shown and the posttest, so the maximum project contact for the students was quite brief. The slide and tape presentation was made by a Black chemist. The slides, and the taped commentary which went with them, were designed to make the same points as did the movie and the television spot announcements. A coordinator whose classes participated in this experimental treatment said that the students seemed very interested in the presentation and asked rather involved, in-depth questions during the discussion period which followed. The total time devoted to the presentation was one hour.

Program Evaluation[15]

The planned evaluation of the impact of the various methods for increasing science career awareness included the scoring of the pre- and post-questionnaires administered to the four experimental groups and the

[13] p. 61.
[14] p. 63.
[15] p. 65.

control group in a way which would indicate the level of science career awareness. The pre-post difference scores were expected to yield an "effectiveness factor" for each of the information dissemination methods. The cost of administering each method was to be divided by its "effectiveness" to yield a cost/benefit ratio. Internal comparisons based on economic level, school achievement level, rural-urban location, and other factors were also planned.

Lack of interest at the schools resulted in complete data from only seven of them and no evaluation report from the project has yet been received. However, there was little likelihood that the evaluation could ever have been carried out successfully, even had the project gone exactly as planned. The scoring of questionnaires according to "what we think the response shows" (as stated in the proposal) without an item analysis or attempts to establish the validity of the instrument would certainly have resulted in massive amounts of random variance and any value arrived at as a cost/benefit ratio for a dissemination method would be spurious unless the method had been presented at its most effective strength. For example, a 15-minute movie shown once could be expected to be less effective than the same movie shown twice (with no additional costs associated with the second showing).

Summary Comment

While this project had many problems of supervision and control, the proposal review panel of NSF is a full partner in the project's fortunes, since many of the weaknesses experienced were fully evident in the proposal.

UNIVERSITY OF CALIFORNIA, LOS ANGELES[16]

"Increasing the Flow of Ethnic Minorities into Careers in Science"

July 1, 1974 - June 30, 1977

Respondents: Project Director, Co-Director, Acting Project Director, Project Coordinator, Ex-Project Coordinator, 2 of 4 Teaching Assistants, 4 of 8 high school personnel, 2 associated non-project personnel

Brief Description

The University of California, Los Angeles is seeking to encourage and promote interaction between its math and science staff and the students and staff in two high schools, one low-achieving and one high-achieving. Forty students from each high school are participating in the project for three years corresponding to the students' tenth, eleventh, and twelfth grades. Two teachers (one math and one science) provide the high school instruction

[16] "Case Study -- University of California, Los Angeles," pp. 67-71.

to classes of 20 students each and are supported by teaching assistants from the University. Teachers participate in summer and academic year pre-service and in-service workshops. During their senior year, participants will take university courses in math and science. Participants will be compared with matched control groups to determine the cognitive and affective effects of the project over the three-year period.

Summary Comment

The UCLA project has just completed its second of three years of activity. Despite some initial problems related to the teaching assistants, the project has been able to carry out two major structural changes in the way science/mathematics classes are taught in the two cooperating high schools. The class size has been reduced from about 35 to 20, and a university graduate student has been employed part-time as a teacher's assistant in each of the classes. This has allowed considerably improved instructor-student contact. In addition, monthly Saturday workshops have put the teachers from the two participating high schools in contact with each other and with the University of California science staff.

The project, which had been operating with part-time direction, is now receiving full-time direction and it is expected that this shift will alleviate the series of minor difficulties the project has been having.

COLORADO STATE UNIVERSITY[17]

"Incentive Program in Science and Engineering"

May 15, 1974 - June 30, 1977

Respondents: Project Director, Research Director, Coordinator, 2 of 15 high school contact personnel, 2 associated non-project personnel

Brief Description

The Incentive Program in Science and Engineering (IPSE) is aimed at testing mechanisms for increasing the flow of minority students into the sciences and technologies. The program is working with 150 students in 15 Colorado high schools which have high enrollments of Black and Chicano students. IPSE made first contact with the students in their sophomore high school year and will remain in contact until their senior year. It will attempt to interest the students in careers in the sciences by stimulating enrollment in existing courses in science and mathematics, providing and supervising a junior year science project, promoting student contact with local high school facilities, and helping students choose colleges and apply for admission. At crucial junctures in the program, participants are tested in order to get a firm idea of how they perceive themselves in relation to job roles and careers, and to monitor how those perceptions translate into concrete preparations to pursue a career in science. Each component of the program will be analyzed as to how effective it has been in contributing to the overall goal and at what cost and effort.

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17 "Case Study-- Colorado State University," pp. 73-78.

Summary Comment

This project (in its second of three years) is attempting the development of mechanisms for stimulating the entrance of averagely qualified minority students (it specifically excludes those with an already well-developed interest in science) into scientific careers. It includes four components which it deems to be crucial: (1) The early (i.e., well before college entry) development of an interest in science, both as a subject to be studied formally in school and as an absorbing intellectual experience; (2) rewarding early experiences obtained from formal and informal associations with the people, tasks, and milieu of science; (3) a developing identification of "self" with the perceived role of the scientist or engineer; and (4) the early translation of a nascent interest and self-identification with science into at least a tentative commitment to study scientific and technical subjects in high school.

The IPSE program has made a substantial start with an initial group of about 150 participants. Progress is being monitored closely and a pattern of relationships has been established or strengthened among students, their counselors, teachers and parents. The students have elected, and worked hard at, regular high school science and mathematics courses with reportedly good success thus far.

TEMPLE UNIVERSITY[18]

"An Experimental Engineering Technology Career Program for Disadvantaged Minority Students"

July 1, 1974 - December 31, 1976

Respondents: Project Director, Outside Evaluator, Advisor, 6 of 7 Instructors, 1 associated non-project person

Brief Description

Temple University is conducting an experimental career program for disadvantaged students at the pre-college level. Participants are minority students who had completed ninth-grade when selection took place. The project is divided into three phases: Phase I - a Career Workshop - involved 15 students recruited from Philadelphia inner-city schools who attended sessions at the College of Engineering Technology four days a week for six weeks during the summer of 1975. Phase II - High School Participation - has provided the students with professional counselors and tutors during the school year. Phase III - Industry Cooperation - arranged engineering-related summer jobs in local industry during the summer of 1976. Upon graduation from high school, these students will be eligible to enroll in the College of Engineering in the Special Technology Education Program.

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[18] "Case Study-- Temple University," pp. 79-84.

Summary Comment

This project, which is just beginning its final two months of operation, has taken a highly selected group of pre-tenth-grade students from minority high schools and attempted to stimulate their interest in engineering during a summer program in which they had the opportunity to learn a great deal about what various types of engineers do. During the following (sophomore) year, the student group reassembled at Temple University on a bi-monthly basis for continued engineering programming and the participants were also provided with counseling and tutorial assistance for their regular schooling when that was needed. This summer (1976), the student participants have been placed in engineering-related summer jobs so that they can have a first-hand understanding of the day-to-day activities of engineers. In addition, a second group of pre-tenth-grade students began Phase I of the program by attending engineering classes at Temple University.

A special effort has been made to keep the program activities at a level which matches the abilities of the participants who, by all reports thus far, have responded with a high level of interest and enthusiasm.

LOS ANGELES COUNTY SUPERINTENDENT OF SCHOOLS[19]

"Minorities and Science Careers:
Counselor Training and Career Guidance Films"

May 15, 1974 - September 30, 1975

Respondents: Project Director, Project Manager, all 4 Technical Consultants, 7 of 27 Counselors

Brief Description

The purpose of the project was to encourage minority girls and boys to prepare for careers in science. The approach was through a training program for school counselors directed toward changing discriminatory counseling practices which depress motivational levels of minority students.

An experimental group of 36 high school counselors from schools with sizable minority populations attended a series of in-service workshops. The counselors examined factors which can lead to unequal educational and employment opportunities for minorities and were exposed to counseling strategies designed to enhance their skills in interaction with minority students and their parents. The project produced five counselor training films for use during the workshops and five career guidance films, and featuring minority scientists, for use by the counselors with their students.

[19] "Case Study -- Los Angeles County Superintendent of Schools," pp. 85-98.

Participant Selection[20]

COUNSELOR PARTICIPANTS: School districts which included high schools with 25% or more ethnic minority population were identified and contact was made with the school superintendents, administration personnel, and compensatory education directors. The intent and scope of the program was explained by the Project Manager and the superintendents suggested specific schools which fit the project's requirements. Then, the Project Manager contacted the school principals, each of whom nominated one or two counselors to participate in the program.

The original plan was for a total group of 36 counselors to attend the in-service training and, since some dropout was expected, a total of 43 were accepted for participation. Twenty-six of this original group completed all aspects of the training program. Of those, 15 were men and 11 women; 14 represented minority groups; and in age, they ranged from 26 to 55.

STUDENT PARTICIPANTS: For the student participants, it was important to find science-eligible tenth-graders, yet it was equally important not to include those youngsters who had already committed themselves to a science interest. Judging by information gathered during interviews with the counselor participants, student selection was carried out with moderate effectiveness. Though most schools did draw random experimental and control groups balanced for minority group and sex, a few schools introduced bias of various sorts. The latter problems were minor, however, and the mix of student participants in the experimental and control groups was not likely to have caused any difficulty in the interpretation of the impact assessment results.

Programming Activities[21]

The activities carried out were considerably divergent from those which had originally been planned. A late start and an unexpected need to subcontract the movie production had a great impact, but a lack of overall program control on the part of the Office of Superintendent of Schools coupled with a lack of understanding of the importance of program evaluation on the part of the Project Manager also contributed greatly to the problems.

The proposed plan was for the development of the content outlines, training films, and the career guidance films to be accomplished by the project manager, reviewed by the advisory body, and produced before the initial counselor training workshop. However, due to the unusual delays cited, the decision was made to go ahead with the training workshops without having the films on hand. Although this created many methodological difficulties, a great deal of positive programming was accomplished. Guest speakers at the training sessions included representatives from many minority organizations, and there were films, group discussions, and group resolution of common counseling problems.

[20] p. 92.
[21] p. 93.

Program Evaluation[22]

Six project objectives were defined operationally and, though never actually spelled out, at least six evaluation measures apparently were planned. However, the delayed acquisition of the films disrupted the plans to carry out the full range of impact evaluation initiatives. There is no indication of any attempt to collect the originally planned pre- or post-measures of student attitudes, student information about science careers, counselors' own information about minorities, counselor contacts with parents, or the number of students enrolling in elective science courses. Though the 10-minute films had been designed to be shown one at a time and followed immediately by group discussion of the issues raised, instead, all five films were shown together leaving virtually no time for discussion. Moreover, none of the counselors interviewed indicated that they had had more than routine contact during the school year with the students identified as "experimental" or "control."

It is unfortunate that the objectives of this project were not achieved because the films ultimately produced seem to be of high technical quality and apparently have been well received by non-project groups which have viewed them.

Summary Comment

To a very large extent, this project was severely crippled by circumstances beyond its control. Even with the problems the project faced, success would have been far more likely had project administrators been able to keep sight of the theoretical underpinnings included in the original project proposal. The project was designed to take place over a specific period of time (five months), to provide a non-threatening supportive training situation within which counselor self-criticism would be invited, and to allow specific strategies and materials to be tried out in the workshop setting and practiced (called "testing") by the counselor at his or her own work site. As circumstances prevailed, the project could have adhered to its objectives only by making concessions in the planned implementation; unfortunately, this was not done and the result is an attractive set of products whose efficacy has not been tested.

[22] p. 95.

THE UNIVERSITY OF MICHIGAN[23]

"Experimental Pre-University Course for Minority Entrants"

May 15, 1974 - October 31, 1975

Respondents: Project Director, Project Coordinator, 2 of 4 Instructional Staff, 7 of 24 Available Participants, 2 of 4 key associated non-project personnel

Brief Description

A six-week pre-university course was conducted for minority group students during the summers of 1974 and 1975 in an attempt to remedy poor preparation in elementary chemistry and mathematics so that the participants could start their pre-professional training on an equal footing with their non-minority counterparts. The classes were taught in two urban centers in Michigan by minority group lecturers and the courses evaluated in association with the Coalition for the Use of Learning Skills (CULS), a campus-based organization dedicated to student academic assistance.

Staff Selection[24]

The staff chosen to instruct the "mini-course" were to be minority chemists with a demonstrated empathy with the problems of first-year minority students. It was planned to have an instructor for every 10 to 15 students and, since the six-week relationship was likely to be an intense one, it was deemed very important that the instructors be compatible with the students. The people finally selected included one who is not Black but had been very successful as a counselor of minority students at the Flint campus of the University, a doctoral candidate from Sudan who had been instructing introductory chemistry courses since 1970 and had participated as a tutor and leader of study groups continuously over that period, a very able chemistry undergraduate student who had assisted in the tutoring program, and a graduate student from Wayne State University in Detroit who was highly regarded as an instructor of minority students.

Participant Selection[25]

Participants were recruited for the program through a newspaper ad in one of the Detroit area Black newspapers, through contact with those on a listing of all the incoming students at the University who had self-identified as minority through application for special financial aids or who had applied from high schools located in areas known to have a heavy minority population, through contact with minority students who attended the Pre-Freshman Day at the University, and through the principal at each of the high schools with which the University worked in its minority recruiting efforts.

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[23] "Case Study--The University of Michigan," pp. 99-112.
[24] p. 136.
[25] p. 136.

All of those students who returned a form indicating their interest in the mini-course were invited, along with their parents, to a meeting where the reasons for having the mini-course were explained (high failure rate in chemistry, especially among minority students; first semester shock; competition with other good students for the first time). Forty-eight or 50 people originally applied for the 1974 program and about 35 attended the first class. The 1975 enrollment was 55, of whom 40 began the course. An additional 15 students signed up for and took the mini-course program at the Flint Campus of the University of Michigan located within the city of Flint.

Programming Activities[26]

The activities were the same for both the 1974 and 1975 summer programs with only slight variations. Of the six weeks of instruction, the first 2-1/2 weeks were spent sharpening skills, with one week (three sessions of three hours each) devoted to improving study habits and the other 1-1/2 weeks to the improvement of those basic quantitative skills necessary for the understanding of chemistry.

At the first meeting of the mini-course each year, a lengthy diagnostic test was administered to the participants to ascertain their quantitative skill level. This measure was then used to divide the group into classes according to skills so that an increased amount of time could be spent with those students whose skills were poorest.

Program Evaluation[27]

The fairly elaborate plans for program evaluation outlined in the proposal were not completely carried out. In 1974, the mini-course effectiveness was evaluated by comparing the chemistry course performance of mini-course participants with that of other minority students who had not attended the mini-course but who had participated in a study group, and to a control group of primarily non-minority students who had received no academic supportive service. Those results indicate that mini-course participants did significantly better than the control group on several variables while there were no significant differences in performance between the mini-course participants and the study group participants.

However, severe methodological problems prevented a more realistic analysis of the impact of the mini-course. Part of the difficulty stems from the fact that specific behavioral objectives of the mini-course were never spelled out. Had they been, more appropriate tests of whether or not those short-, mid-, and long-term objectives had been achieved could have been devised.

Despite the lack of formal evaluation, there are indicators from participant interviews which suggest that the mini-course fulfilled important functions: It gave the participants a realistic preview of both the content and the difficulty level of the freshman chemistry program, it seems to have

[26] p. 109.
[27] p. 110.

improved their confidence in their own ability to compete successfully with non-minority students, and it provided an opportunity for students to test their own study skills at a point in time when the cost (normally, falling behind in course work, poor grades or failure on hour exams, or even course failure) of repairing deficiencies is not great.

Summary Comment

The mini-course idea has a number of things to recommend it as a technique to reduce failure and dropout rates of minority students in science courses. Though the program's instructional benefits may not be greater than the benefits from other kinds of assistance, such as tutoring or study groups, it would seem to have advantages in its ability to recruit participants by operating on their own territory and accommodating to their needs to hold jobs during the summer period. The approach provides a high teacher-to-student ratio at very moderate cost by its use of empathetic graduate students as instructors. Finally, the mini-course seems to generate an enthusiasm and self-confidence in its participants which, in itself, is a valuable attribute in a competitive situation, whether a chemistry class or any other endeavor.

THE UNIVERSITY OF NORTH DAKOTA[28]

"An Experimental Pre-Professional Summer Institute for American Indian Students in Engineering"

May 15, 1974 - November 30, 1974

Respondents: Project Director, Project Coordinator, 3 of 5 Instructors, 3 associated non-project personnel

Brief Description

The University of North Dakota conducted a summer training program in engineering for native American students. The primary objectives were to help immediately qualified Indian students to enroll in an engineering school (University of North Dakota) and to help Indian-controlled junior/community colleges develop pre-engineering and engineering science curricula. The American Indian Higher Education Consortium, Incorporated (AIHEC) participated with the University of North Dakota in carrying out this project.

Staff Selection[29]

None of the teaching staff in the University of North Dakota Department of Engineering were native American, but an attempt was made by the project administrators to recruit instructors who had experience teaching Indians as part of other native American programs at the University. Delayed funding required some changes in the original group selected, but a seasoned staff

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[28] "Case Study--The University of North Dakota," pp. 113-126.
[29] p. 121.

was assembled and the final group of five included a full professor, an associate professor, and three instructors.

Participant Selection[30]

In a situation such as the one in North Dakota where qualified individuals are expected to be relatively scarce in the general population, the recruitment and selection processes become especially important. The original conception was of a very wide recruitment area with concentration on applicants who had an expressed interest in engineering. Preference was to be given to students who were attending or who expected to attend communit colleges. Selection was to be on the basis of past performance and a review by a three- to six-person panel. Several of the people associated with the project agree that the identification and selection of participants was expected to be a lengthy task requiring about three month's time.

However, a May release of NSF grant monies coupled with a University of North Dakota summer session which began in late May, reduced the recruiting effort to a quick sweep of nearby reservations to fill the 20 vacancies which had been funded. The selection panel was never constituted, transcripts and test scores of the applicants were never acquired, and the Indian community colleges had been dismissed for the summer. Apparently the sole criterion ultimately used was the individual applicant's expression of interest in engineering.

This lack of selectivity very quickly became the crux of the project because the group which arrived at the University of North Dakota was not the originally expected, highly motivated community college or pre-college students with engineering interests. Instead, the group actually included many high school students whose commitment to engineering was open to question and whose academic qualifications were unknown. They arrived at the University campus to find a program of instruction much more concentrated than most had ever faced before, and with extremely technical subject matter for which few had the necessary background.

Programming Activities[31]

It had been assumed that the student participants would have various deficiencies in their academic background relative to the subject matter being taught during the summer program, so it was planned to have a tutor/counselor attend all of the classes and be available to provide assistance on an "on call" basis, day or night.

The planned instructional activities were less considerate of the participants. The teaching plan was determined well before any participants had been recruited and no apparent effort made to match the instructional schedule to the needs of the specific individuals; either those who were expecte or those who actually attended the summer session. When the participants complained about the very heavy class schedule, outside activities were interspersed more freely among the classes, but the actual number of hours of class instruction was not reduced. As a result, class attendance dropped to very low levels.

[30] p. 122.
[31] p. 124.

To supplement the classes, an arrangement was made with the Indian Health Service to provide engineers to visit the project, make formal presentations, and spend some time with the Indian students. Judging by the attendance at these sessions and instructor interviews, the students were enthusiastic about this aspect of the program.

Program Evaluation[32]

This project did not include an organized attempt at program evaluation. The planners felt that if any of the participants were able to enroll in an engineering curriculum after the summer project was complete, it would be a positive outcome. In the project's final report, the Director recounts that of the 14 formally enrolled students in the summer program, six entered college, but not in engineering departments. In addition, there were two students who participated but were not formally enrolled in the project and one of them reportedly did matriculate in the College of Engineering at the University of North Dakota. Comments from two of the instructors indicate that this one person had been very positively affected by a combination of the program and the people associated with it.

Summary Comment

As originally laid out, this project had the opportunity to be a fair test of the hypothesis that a concentrated summer program was a useful strategy for identifying and, to some degree, rectifying the academic deficiencies of native American students interested in engineering careers. The project concept was patterned on a successful program in the medical field and had the benefit of the experience of that program in dealing with identification, selection, and training problems of Indian students. It had been planned to recruit over a very wide area, and final selection of the 20 participants was to be done on the basis of a variety of academic and motivational criteria. Funding which arrived much later than expected prevented adequate recruitment and selection of the participants which, in turn, led to the many problems which disrupted the program.

OLIVE-HARVEY COLLEGE[33]

"A Pre-Engineering Summer Institute"

May 15, 1974 - January 31, 1976

Respondents: Project Director, original Project Coordinator, subsequent Project Coordinator, All 5 Instructional Staff Members, 2 of 3 key associated non-project personnel

Brief Description

A pre-university course of eight weeks was conducted during the summers of 1974 and 1975 to prepare promising minority high school and community college students to meet the academic requirements of any first-year comprehensive engineering program. The main subjects covered were mathematics,

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[32] p. 125.

[33] "Case Study--Olive-Harvey College, Chicago," pp. 127-140.

chemistry/physics for engineers, and "Man and His Environment." Report writing and English skills were emphasized in this last course.

Arrangements were made to have students who successfully completed this program enter Cornell University, Illinois Institute of Technology, or the University of Illinois.

Staff Selection[34]

As was true with most of the other projects which involved summer programming, late funding from the National Science Foundation disrupted recruitment at Olive-Harvey. Project plans had called for the employment of two instructors plus a project coordinator who would also serve as the third instructor. As the summer drew closer with no funding announced, two of the original three people who had been asked to work on the project withdrew, including the originally desired coordinator. Then, when the award was made and funds did become available in June of 1974, a rushed effort was necessary to staff the project. The result was a young but able group of instructors which had expertise with both college and high school students, but not with program planning or execution.

Participant Selection[35]

Through regular Olive-Harvey contacts with high schools and through the personal efforts of several people on the Olive-Harvey staff, preliminary recruiting had begun well before the June starting date of the project. Review and examination of transcripts and other application materials from nearly 60 students had resulted in 30 candidates being identified for selection. By the time the Board of Trustees had formally voted acceptance of the late May NSF award, and subsequent staffing completed, the number of selectees who had not made alternative summer plans had dropped to 18.

The small number of participants during the first summer program (and the associated cost savings) prompted an early request to NSF for permission to conduct a second Summer Institute with the project's unexpended funds. There should have been ample time for recruiting and planning for the second summer, but critical personnel turbulence had taken place: Both the Project Director and the Project Coordinator had left the college and the only staff holdovers from the first summer program were two neophyte instructors, neither of whom had organizing experience. Thus, by the time a staff had been reconstituted for the second summer's effort, participant recruiting was well behind schedule.

Ultimately, each of about 70 applicants was telephoned by a member of the project staff and questioned about his or her math and science background. About 45 students were accepted, of whom 31 registered on the first day of the summer program. Most of the participants had just completed their junior year in high school, but five were only sophomores.

[34] p. 133.
[35] p. 134.

Thus, there was a significant difference in the participant populations of the two summers. During the first summer, the students were predominantly high school seniors who had already qualified for college acceptance and who were motivated by the opportunity to sharpen their college-required skills. The second summer's participants were mostly a year younger, had completed fewer science and math courses, were not necessarily college-bound, and were, therefore, not as strongly motivated, since potential benefits were more remote.

Programming Activities[36]

During both summers of the project, the activities engaged in by the participants were primarily academic and included instruction in algebra, biology, physics, and chemistry. In addition, small group and individual tutorial assistance was given during daily "laboratory" sessions which concentrated on problem-solving, reading improvement, and development of study skills. There were also presentations from guest minority engineers representing educational institutions and minority engineering firms plus (during the first summer only) at least three trips off-campus to sites of engineering interest. Altogether, there seems to have been a coordinated program of instructional and support services designed to provide the students with positive experiences with, and the academic preparation for, the content of engineering.

Program Evaluation[37]

The only indicator of project success shown in the report of the first Summer Institute was a listing of the status of the participants three months after they had completed the summer training program. Ten of the 18 participants were enrolled in various engineering programs while an 11th was in a liberal arts program. Two others were still in high school, and five had completed high school and were working. There is no way of knowing how many of the participants had been planning studies in engineering before enrolling in the Summer Institute, so the direct effect of the program cannot be judged.

Following the second summer, a questionnaire was sent to each of the 20 students who were considered to have completed that program. None of the four who had graduated from high school were attending an engineering school, though 13 students said that their experience at the Summer Institute had given them an incentive to pursue engineering as a career.

Summary Comment

With this project, as with others, the success of the techniques being tested was obscured by the absence of any real program of evaluation. The project experienced further problems, especially during the second summer of its operation, as a result of its shifting leadership and the consequent loss of single-minded focus on the project's original objectives and methodology.

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[36] p. 137.
[37] p. 138.

THE UNIVERSITY OF MASSACHUSETTS[38]

"Identification of Ethnic Minority Students for Science and Engineering"

May 15, 1974 - August 31, 1975

Respondents: Principal Investigator, Project Director, Associate Project Director, Program Assistant, 7 of 8 Instructional Staff, 8 of 18 successful Participants, 3 of 4 key associated non-project personnel

Brief Description

The School of Engineering of the University of Massachusetts carried out an experimental project to identify, counsel, and prepare a group of minority students for college entrance. Twelfth-year vocational high school students were identified on the basis of their acquisition of minimum math and science skills and met at their schools with project staff in group sessions designed to enhance and stimulate the participants' interest in engineering.

Each student's suitability for acceptance to the School of Engineering, University of Massachusetts was assessed by interview procedures and aptitude tests developed jointly by project and School of Engineering staff in the expectation that the potential ability of these students could be measured in that way without the socioeconomic and cultural biases inherent in standard qualification tests.

The stated goal of the project was to have at least 14 of the student participants enrolled in the School of Engineering in the fall of 1975 and this objective was met.

Staff Selection[39]

The requirements for the core staff positions were for people with an engineering background or an expertise in mathematics and who were mature enough to carry out what were expected to be rather delicate negotiations with the high school teacher super-structure. It was also seen as vitally important that the core staff be members of minority groups.

The high school instructors who would teach the project participants were also selected with great care. Since these local monitors, who were generally science or math teachers and nearly all White, would act as an extension of the project staff and would work very closely with the project, each candidate was interviewed by the core staff for about an hour during which the instructor's racial attitudes were challenged by stressing the minority aspects of the program. Each teacher was then observed in class by a core staff member. Particular attention was paid to the degree of empathy toward minority group students displayed by the instructor.

[38] "Case Study--The University of Massachusetts," pp. 141-156.
[39] p. 148.

Participant Selection[40]

The basic premise for the project was that there exists a large untapped pool of minority students who are potentially capable of pursuing college careers in engineering but who are enrolled in vocational high schools, primarily because of socioeconomic factors beyond their control. Even though they may not have had the opportunity to acquire the requisite mathematics and science background, they do have the aptitude to succeed in a college engineering program.

Eight vocational high schools were selected for participation in the program: five in New York City, two in Connecticut, and one in Massachusetts. Each school was asked to identify those students who had ability or potential in mathematics and to consider especially those students who had been problems in the classroom due to boredom or lack of challenge.

The resulting 200 student nominees were interviewed by the core staff and evaluated on their maturity, their ability to deal with change, and indications of drive. From the 200, 57 participants were selected of whom about half were Black and half Hispanic.

The incentives from the students' point of view were extremely strong. Each knew that about 50 participants were to be selected and that the Engineering School of the University of Massachusetts was keeping at least 15 places open for those who successfully completed the project. Therefore, each had about one chance in three to be accepted for university studies; something which most participants had believed to be beyond their reach.

Programming Activities[41]

The first activity of the project was the visit of the 57 participants and eight instructors to the University of Massachusetts for a two-day orientation session. Activities at the individual high schools began about two weeks later. Most of the classes were held after school, though at one location, program activities were conducted for an hour before school and for a second hour during the lunch period due to job involvement of several of the participants.

The objective of the program was to assess the vocational high school student's math aptitude by having the student build a radio device, the construction and performance of which is based on fundamental mathematical principles. It was assumed that the student's ability and perseverance in applying mathematical skills to a practical project would give an indication of the student's interest in pursuing a technical career.

The first phase of the program was quasi-instructional in order to give the students some basic concept of the operation of a simple AM radio. The second half was the construction phase, and called for the student to design and build a capacitor element to replace one which had been removed from the radio kit which the student had previously built. The "final examination" was a detailed technical report of the design and construction activities.

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[40] p. 149.
[41] p. 151.

Program Evaluation[42]

A planned summative evaluation of this program is still incomplete as of this writing, but there are several indicators of project success. Of the 37 participants who persisted to the end of the project, 18 were admitted to the University of Massachusetts. Of the 19 who were not, nine have been admitted to engineering programs at other institutions of higher education. Reports from the instructors, supported by interview responses of participants who are attending the University of Massachusetts, suggest that prior to program involvement only a handful of the participants had any plans to continue formal education past high school.

The first-year engineering school success of the 18 participants at the University of Massachusetts has not yet been fully documented, but there has been no attrition during this period and all returned to the University in the fall of 1976. Six of the 18 have achieved "outstanding" records.

Summary Comment

The University of Massachusetts has apparently been successful at combining the existing resources of vocational high schools and an engineering school in an innovative fashion which is capable of identifying potential engineering students with high ability but who lack the usual formal credentials for engineering school entrance. The project was characterized by unusually careful planning and uncompromised criteria for the selection of both instructional staff and student participants. The success of this aspect contributed greatly to the project. Support from the parent institution was impressive and excellent working relationships were established between the university and the several participating high schools.

[42] p. 154.

5. DISCUSSION OF CASE STUDIES[43]

As a direct result of the experience of the NSF-funded projects, a number of issues arise which may have policy implications for NSF and which certainly should be considered by both the proposers and the reviewers of future research plans.

The single greatest project difficulty was an inadequate evaluation plan. In practical terms, an innovative intervention technique will get wider use only if other people can be convinced that potential results will be worth the effort. Without evaluation, there can be no clear idea of program effectiveness and when relative effectiveness is unknown, it is not possible to weigh one potential technique against another.

A few of the efforts in this study included no evaluation at all. Of those proposers who did attempt assessment, many did not try to identify and measure those outcomes which were most closely related to what the project was seeking to accomplish. Some recognized that it was important to establish "control groups," but frequently this was done by rote without enough consideration of the issues in question. Often, in such cases, the partial controls which eventuate from a broken research design can obscure, rather than elucidate, the impact of a project.

It seems evident that it would be much to a potential project director's benefit to make some early decisions about which behavioral outcomes are expected as a result of a propored input, what behaviors could be considered intermediate indicators of those outcomes, and which techniques can be used for measuring those behaviors. If such a self-examination were routinely incorporated in every proposal, it is likely that project quality would be substantially improved.

Even among those projects which scheduled evaluation, there was apparently little or no thought to an evaluation strategy. Far more than the mere detailing of the expected evaluation outputs and how they relate to the purposes of the project, the objective of an evaluation strategy is to choose the most central concern of the program effort, decide upon the behaviors most likely to be changed if program expectations are met, and make certain that an attempt is made to measure that change. For example, two of the projects under discussion attempted to impact on students through the special training of school staff (teachers and counselors, respectively). Virtually all of each project's effort was directed toward the staff, yet in neither case was any attempt made to determine the degree to which the participants incorporated the new elements into their contacts with their students.

The concept of an evaluation strategy also has implications for the point in time when the most vigorous evaluation effort should take place. Virtually all evaluation attempts among the present group of projects were of a short-term nature, but there are no good rules of thumb which can be used to relate the short-term success of an effort to mid-term success (not to mention "ultimate" success). An overall evaluation strategy would have

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[43] Abridged from Chapter 3 (pp. 15-22) of the full report.

helped the project planners to select that point in time when change was most likely to be related to the central concerns of the project so that impact assessment could be more meaningful. In the studies alluded to above, evaluation on a short-term basis (e.g., increase in the level of information of the teachers) would have been more appropriate than the intermediate-term assessment of student interests actually attempted, while long-term evaluation was most relevant for another project which diverted participants out of one success stream (vocational school graduation and immediate entry into a technical profession) into an engineering program where potential success was some years away.

This discussion does not imply that non-optimum evaluation should not be done or is of little consequence. On the contrary, in many cases intermediate measures are the only ones possible and nearly any well-thought-out evaluation attempt will yield pertinent information. But *it should be recognized that the more remote an evaluation is from the optimum for a specific input, the less clear-cut the results are likely to be. This is especially true when there is disruption by unanticipated intervening events, since this results in an inability to demonstrate the effectiveness of an intervention process even though the underlying premise and the major part of the execution may well be sound.*

The proposers of many of the projects failed to acknowledge the state-of-the-art of the various mechanisms employed in their planned intervention strategies. Summer training programs have been tried before in other contexts, special training sessions to sensitize people to various kinds of human relations issues have a long history in industry, there has been some experience with both filmed and live role models, and there is much information regarding filmed presentations of many different kinds of material. These are not project issues; they are pre-project issues, but few of the project planners based their utilization of these sorts of techniques on the lessons learned by others. *From the point of view of both the proposed project management and NSF, it would seem to be most desirable to establish with some confidence that the vehicle is right for the purpose before entrusting it with valued freight.*

Another major problem area among the studies in this evaluation has been that of project management. In several cases, major responsibility was delegated to individuals whose experience, however strong in some areas, did not prepare them for the overall coordination of a broad research effort. This, by itself, is not necessarily bad if backup is provided, but in each of three cases the one person who did have a complete theoretical overview of the objectives of the project was not sufficiently available to the project coordinator to prevent those objectives from being lost from view amidst the day-to-day difficulties of establishing an operational program.

Very few of the project proposals included a clear delineation of what the project tasks were to be and who would be responsible for carrying them out. It would be beneficial to potential projects if proposals included this information in substantial detail. Lines of control and responsibility should be specified so that critical compromises are not made to the detriment of the ultimate project goals.

Participant selection proved a problem for several of the projects. Two efforts were critically hampered by the inability to recruit participants of the type they had been programmed to deal with. Each project was faced with a delayed start and elected to make concessions in the area of participant quality in order to increase the number of people with whom to carry out the program. In both cases, this decision led to a level of participant motivation which was much lower than expected, and this seriously affected the impact of the intervention techniques being tested.

Participant selection cannot be treated casually. The rationale upon which a project's effort is based determines whether participants should be an optimal group or a typical group. Since the project programming logically must be quite different to bring a substitute participant group with different credentials to the same ultimate point planned for the original group, substitute participants rarely work out.

Participant motivation is a strong factor related to the success of a project but it was largely ignored during project planning. Many things can be motivating and different things motivate different people, but psychology has developed a few rules-of-thumb which can be useful guides. For example, near-term rewards are more motivating than distant ones, rewards related to strong desires are more motivating than rewards related to weaker desires, and rewards related to goals people set for themselves are more motivating than rewards associated with goals set for them by others. Real life and real projects are rarely as clear-cut as this, but *formal project consideration of the motivating influences at play in a given project situation would help to avoid the expenditure of money and effort when an analysis shows motivation is likely to be very weak.*

Since it is clear from the experience of these 11 projects that the success of an intervention strategy is by no means assured, it seems imperative that when students are to be directly impacted by an attempt at intervention, the proposal discuss the possible consequences to the student of project failure. These consequences would seem to be of different orders of magnitude depending on which of two general categories the project effort falls into: attempts to conserve within the science pool students who otherwise would be expected to drop out, and attempts to stimulate students to consider science subject areas who otherwise might not do so. There are different things at stake in the two types. Conservation implies remediation of elements in a participant's background which have been deemed ineffectively learned. The process of identifying those elements carries some taint of "failure" to the participant. Under those circumstances, it seems especially important for a project to provide the participant with a situation in which success is probable, because continued failure, especially under the protective umbrella of a "special project," could be devastating to any hope a participant might have of entering a science profession.

The stimulation of new science interest implies a controlled environment in which many of the usual consequences of individual failure are absent or reduced in impact. The failure of a project of this type to achieve its goals would seem to have much less adverse impact on participants since their experience would be to miss out on an "extra" rather than to fail at something "essential."

The experience of several projects in this study raises a question: Can educators be expected to change their accustomed behavior for a special purpose? Realistically, within the limitations of projects of the present scope, the answer seems to be "no." At least, the four projects which tried to do so met with very little success and two other projects, specifically recognizing the difficulties, opted not to try. *The argument here is not that it is impossible to convince educators to change the way they carry on their professional duties; rather, for a variety of good, practical reasons (including the temporary nature of an experimental project) it is very difficult to do so. Thus, projects which propose this sort of behavior change as a crucial element should be appraised with skepticism.*

None of the projects experienced much difficulty linking with outside elements. Teachers contributed time, school principals allowed the use of their facilities, guest speakers made appearances (sometimes traveling long distances to do so), and student trips were arranged, all with relative ease. *The experience argues for the inclusion of this type of element in a project without a qualm whenever it seems appropriate to do so. However, there is caveat: When a project requests free assistance from outside individuals, as is frequently the case with teachers or consultors, their enthusiasm and cooperation are likely to waver unless the project provides them with some compensating benefit.*

Two projects produced films as a basic component of their intervention strategy. In both cases, the impact value of the films was not able to be assessed, partially for reasons related to the film production itself. More than $52,000 of NSF grant money was spent on production costs (not including project personnel salaries or associated costs) and this sum is larger than the overall budgets of five of the 11 projects. The outcomes of this expenditure are products of high technical quality which were used once for the purposes of the project which produced them but, because their impact is unknown, are likely to have very limited utility in the future. *Film-making is complex and very costly and, given the problematic outcome of any research project, it is questionable whether science research funds should be utilized in this way.*

6. TYPICAL EDUCATION FLOW PATTERNS[44]

In order to provide a context for the NSF-funded minority projects and their potential impact on the science education of minority students, it seemed necessary to gain an overall picture of the typical education flow pattern for each of the minority groups involved. The result of that effort is the series of diagrams included in this chapter.

The data has been assembled from a very large variety of sources. The intent has been to provide a picture of the education experience of the various subgroups as it now exists because that is the basis on which intervention attempts will have to be made. The diagrams do not represent the experience of any single cohort as it passes through the various stages of education; rather, they display the best information available for each stage, even though that information may be based on data collected a year or two earlier or later than the data for the next stage. In many cases, the information presented has been adjusted so that it does not conform exactly to available published data. That adjustment is of two types: When data from two or more sources was inconsistent, the figure in the diagram represents a judgement based on the relative recency of the sources and the methodology of the original data collection; when the best available data is relatively old, the figure presented in the diagram has been adjusted to conform more closely to recent experience even though the latter may be narrowly based or informally documented.

In spite of the fact that the education flow figures necessarily are approximations, the set of diagrams is a useful tool for a number of applications:

--Relative educational experience can be compared easily both longitudinally from step to step within the education process, and across ethnic groups. Points of divergence are readily identified and the areas of greatest need become immediately apparent.

--The cumulative experience (such as the number of college graduates as a proportion of the entering freshman class) can be determined quickly by entering the diagram at any point with an assumed base of 100 and then multiplying by the percentages found in the succeeding boxes up to the education level which is of interest.

--The diagrams can be used to yield a rough gauge of the relative cost-effectiveness of different types of approach. For example, an intervention strategy carried out at the high school level would have to demonstrate considerably greater effectiveness, or cost considerably less per student, than a strategy carried out during the freshman year at a four-year college in order to be equivalent in ultimate impact because of the normally high dropout between high school completion and the onset of post-secondary education.

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[44] This section is a slight abridgment of Chapter 17, pp. 159-170.

Figure 1 shows the Typical Education Flow Pattern for Black students as compared to that of White students. The overall picture is one of a persistent decrement in retention at the various stages of education. There are no points of large-scale divergence, though there is still an important difference in the high school completion rate. The proportion of students who successfully complete two-year institutions and transfer to four-year institutions also appears to be somewhat less for Blacks than for Whites, though these figures may contain a somewhat larger degree of error than most of the others due to a relative lack of data relating to this issue.

The differences shown in Figure 1 cumulate as the education process unfolds. Of those students who enroll in first grade, 42% of Whites and 36% of Blacks enter higher learning at either two- or four-year institutions. Calculated on the same base, 14% of White students and 11% of Black students graduate from four-year colleges or universities and 5% of White first-graders earn a baccalaureate degree in a science field while only 3.5% of the Black youngsters do so. (All of the above figures can be found from the diagram by multiplying the proportions at each step shown.)

Figure 2 shows similar information for Mexican American students in comparison with White students. The overall pattern is one of fairly large-scale divergence from the experience of Whites until the point of entry to four-year institutions of higher learning. Here, the differences persist but are generally of a smaller order, except for the relatively high first-year dropout for Mexican American students. There are two points where the differences between Mexican American and White students are extraordinarily large: The proportion of Mexican American students who enter two-year institutions is nearly double that of White students; while of college/university graduates, only half the proportion of Mexican American students enter graduate school in science fields as do White students.

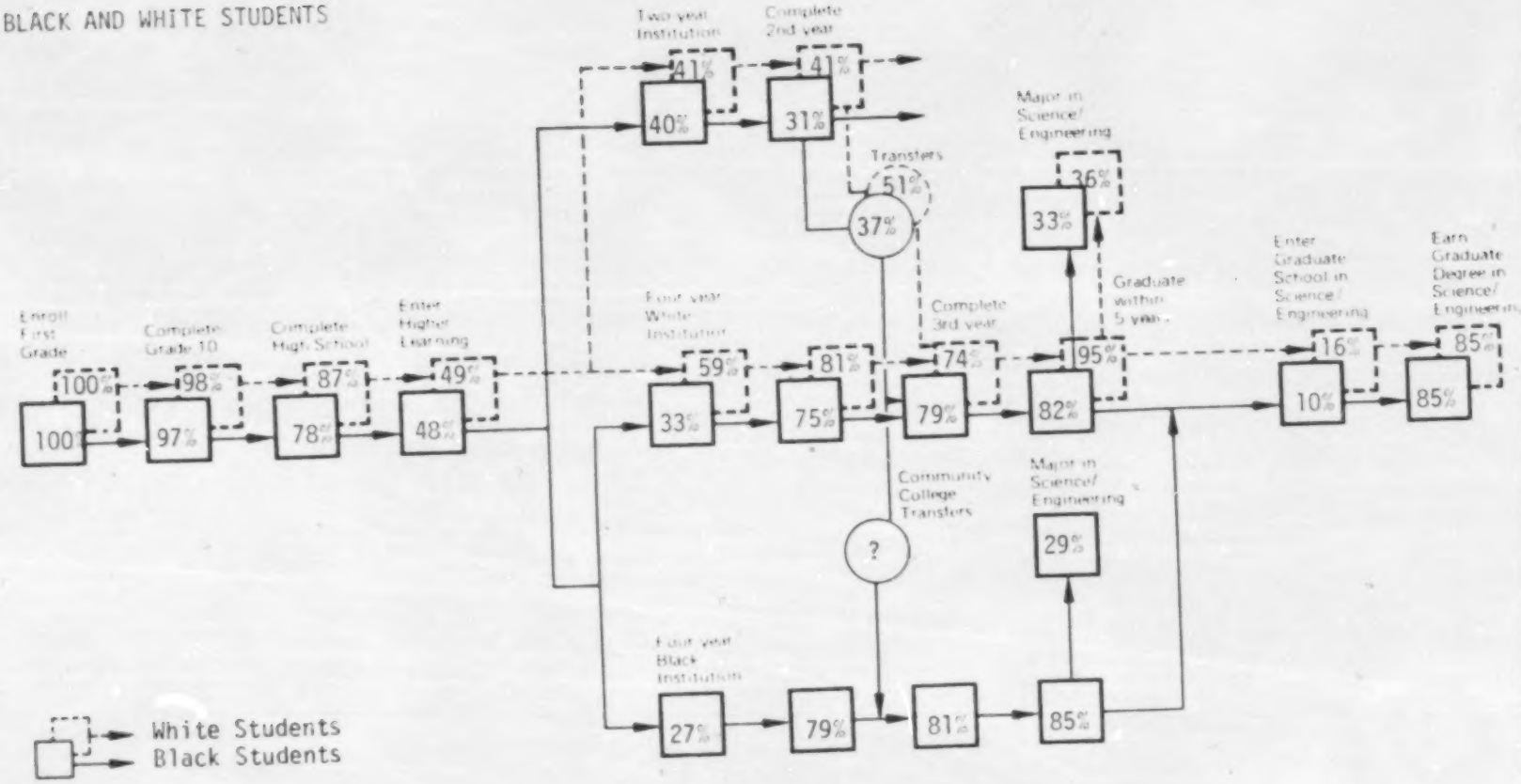
The cumulated educational experience of Mexican Americans reveals that of those who start first grade, 23% (vs. 42% for White students) enter higher learning, 3% (vs. 14%) graduate from four-year colleges or universities, and only 1% (vs. 5%) obtain baccalaureate degrees in science or engineering.

Figure 3, though incomplete, shows the education experience of Puerto Rican students as far as could be determined. Information acquisition was impeded by the fact that in statistical studies Puerto Ricans have been lumped together with Mexican Americans, Cubans, and others under the general rubric of "Spanish surname." There is obviously an immediate need to correct this problem so that education priorities can be set.

From the data which is available, it can be seen in Figure 3 that only about half as many Puerto Rican students complete high school as do White students, though of those who succeed, approximately equal proportions of Puerto Ricans and Whites enter two- and four-year institutions. It is important to note that Valdivieso, in his 1976 report concerning Puerto Rican high school dropouts, estimates that at high school age, as many as 25% of Puerto Rican students are a year or more behind their age-grade. This, of course, has a strong effect on the persistence figures collected at the usual points in the education process.

TYPICAL EDUCATION FLOW PATTERN:

BLACK AND WHITE STUDENTS

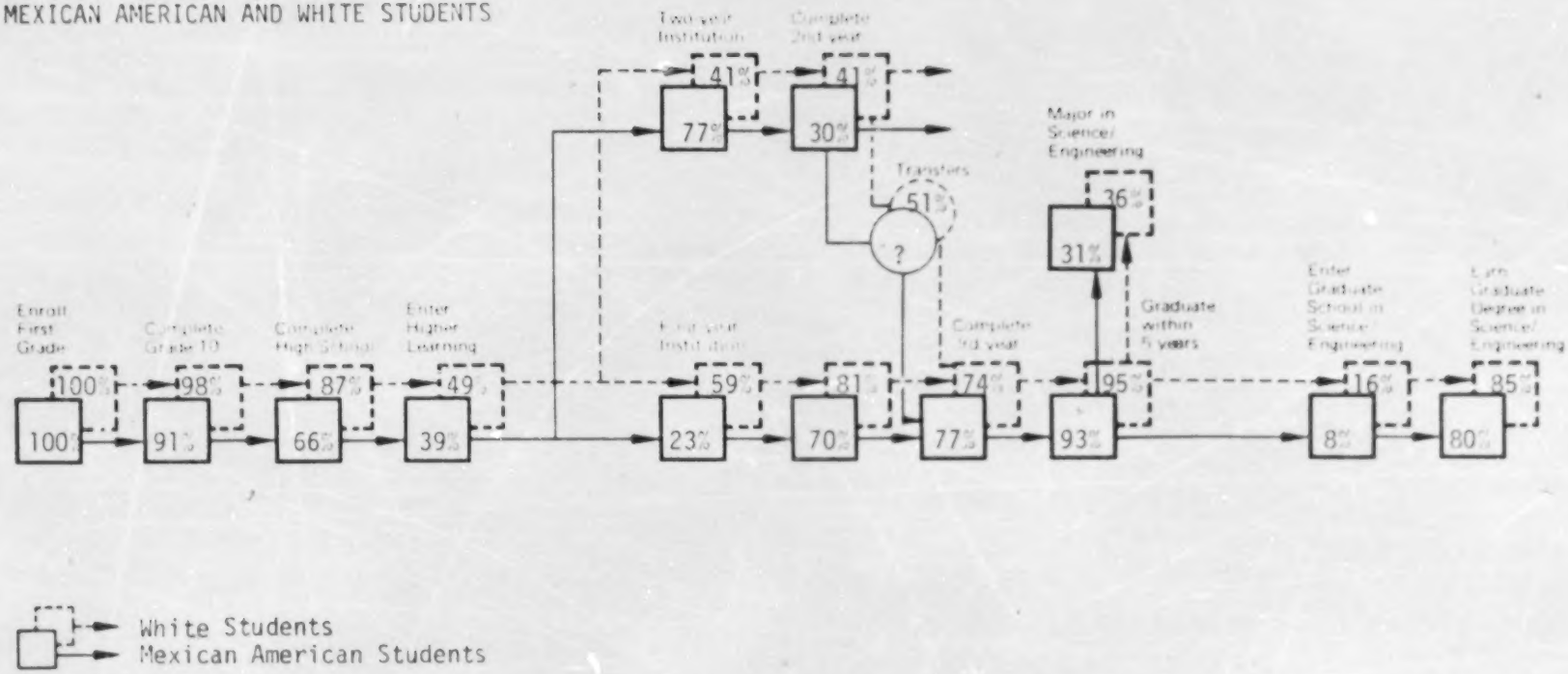


NOTE: Each figure represents the proportion of students from the previous stage who continue their studies.

Figure 1.

TYPICAL EDUCATION FLOW PATTERN:

MEXICAN AMERICAN AND WHITE STUDENTS



NOTE: Each figure represents the proportion of students from the previous step who continue their studies.

Figure 2.

TYPICAL EDUCATION FLOW PATTERN:

PUERTO RICAN AND WHITE STUDENTS

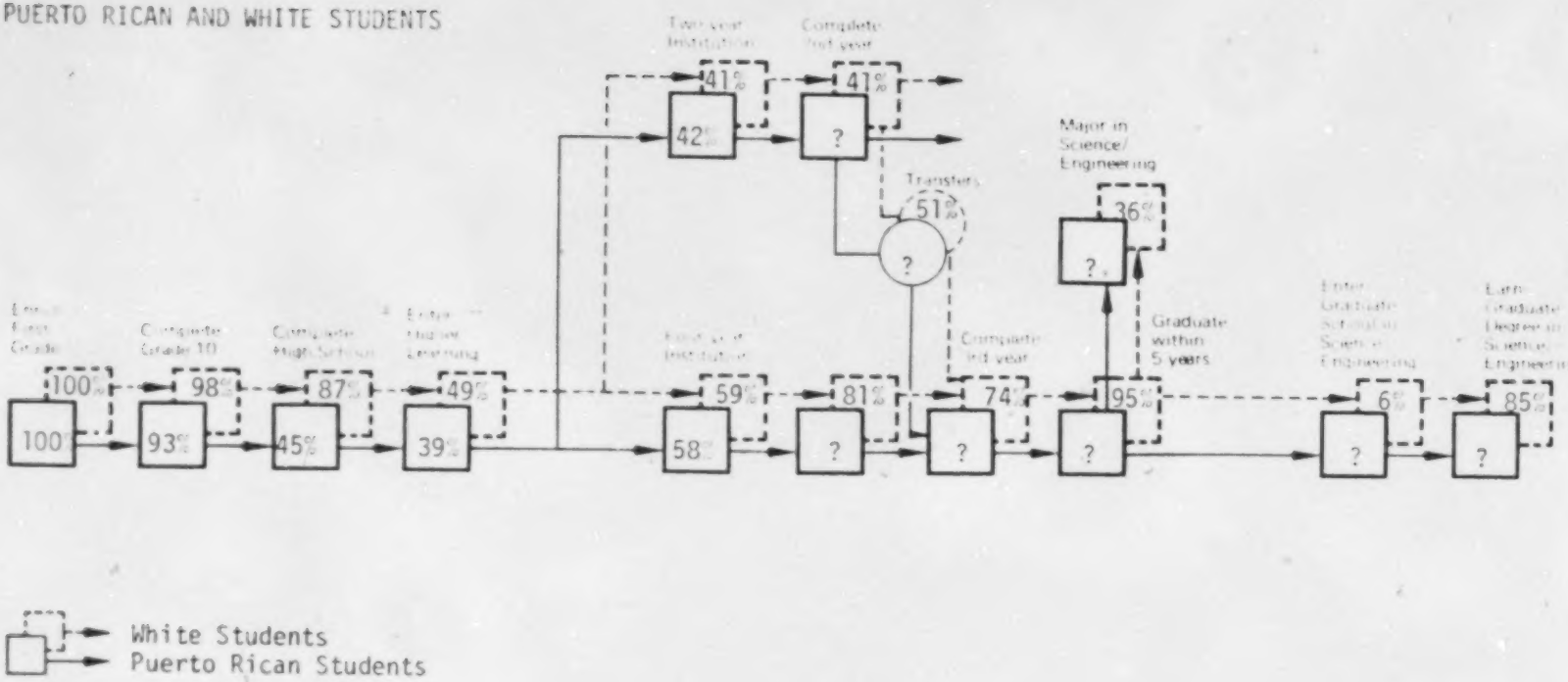


Figure 3.

A much clearer picture is available for native American students (Figure 4). The most complete data comes from the Bureau of Indian Affairs (BIA), though only a minority of Indian students attend BIA schools. Surveys carried out by the Office of Education cover a different base population than do BIA surveys because of differences in the way the two organizations define "native American." BIA includes only those people who are on tribal roles, and therefore a relatively larger proportion of people living in rural areas, while the Office of Education definition includes anyone with a specified minimum proportion of Indian blood who self-identifies as an Indian, and thus incorporates many unaffiliated city dwellers. As far as possible, these two major sources of information have been reconciled in Figure 4. It should also be pointed out that most of the information related to attendance at institutions of higher learning comes from the Bureau of Indian Affairs, which administers a scholarship program which provides at least some funding to the majority of native American students engaged in post-high school education.

The overall pattern in Figure 4 for native American students shows that their relative retention rates through high school are somewhat lower than for White students and that there is an even larger difference during the years of higher education. Of those who enter four-year institutions, 57% of White students ultimately graduate while only 40% of native American students do. These figures for native Americans are undoubtedly affected by their rather high dropout/drop-in rates, which must make it hard to determine who is enrolled and who is not.

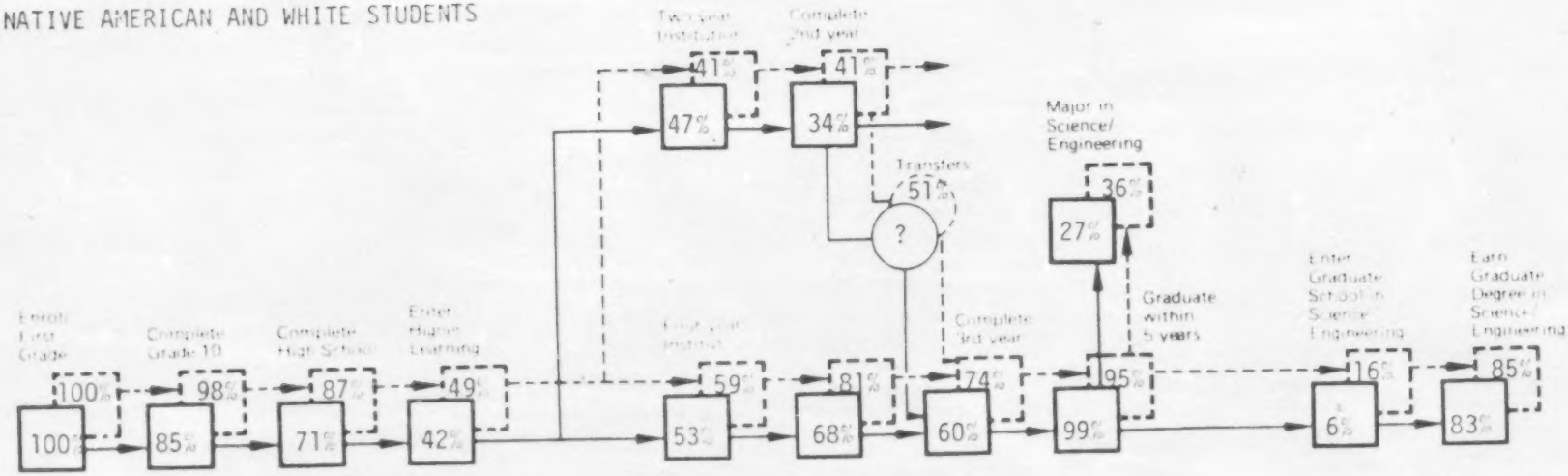
To complete the comparison, of those native Americans who enroll in first grade, 25% (vs. 42% for Whites) enter higher learning, 5% (vs. 14%) graduate from a four-year college or university, and 1.5% (vs. 5%) major in science or engineering.

The comparative education experience of the three less numerous minority groups is shown in Figure 5. Some of the major priorities are immediately evident: Compared with the other groups, many native American youngsters drop out of the education process prior to the completion of the tenth grade; among Puerto Rican students, the major drop in retention rate occurs at the point of high school completion (Mexican American students are also lost at a fairly high rate at that point); the three groups have approximately equal rates of entry into higher education after completion of high school, but less than half as many Mexican Americans attend four-year institutions as do students from the other groups; and native American students have a large dropout rate during their years of higher education.

The priorities for Black students (Figure 1) are not as clear-cut. As already pointed out, Black retention rates approximate those of Whites at most points in the process and are somewhat greater than the other three minority groups. However, it is quite clear from the cumulated rates that there are still significant differences between the Black experience and the White experience in education. This is especially true when the number of those entering graduate training in science fields is considered.

TYPICAL EDUCATION FLOW PATTERN:

NATIVE AMERICAN AND WHITE STUDENTS

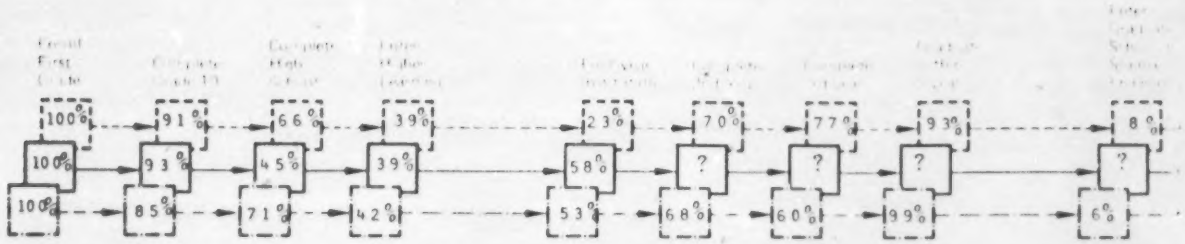


White Students
Native American Students

NOTE: Each figure represents the proportion of students from the previous state who continue their studies.

Figure 4.

TYPICAL EDUCATION FLOW PATTERN



Mexican American Students

Puerto Rican Students

Native American Students

Figure 5

7. RECENT MINORITY SCIENCE EDUCATION INTERVENTION ATTEMPTS[45]

The 11 NSF-funded projects are, of course, only a few of the attempts made over the past few years to increase the participation of minority students in science. The Office of Opportunity in Science of the American Association for the Advancement of Science (AAAS) has completed an inventory of those science education projects for minority students carried out from 1960 through 1975. While their report was in preparation, they allowed AIR to have access to their files and most of the information in this chapter is from that source. The approximately 400 projects which AAAS cataloged, while not all-inclusive, do represent a broad variety of attempts to improve science training of minority students.

Nearly 100 of the projects dealt with the age groups of interest in this report, so to lend context to the NSF-funded efforts, these were abstracted and categorized by AIR. While it was apparent that a variety of different approaches have been tried, very few of the programs made any attempt to evaluate their own impact and there is not one longitudinal study among them (though several follow the students for two or even three years). Most of the projects simply offered "exposure" to science with the apparent expectation that that would improve the overall quality of students' familiarity with science-related things. This general lack of impact assessment makes the group of NSF-funded projects all the more interesting because the large majority of those did include some evaluation plans.

Of the 95 different efforts, more than half were aimed toward high school students and the great preponderance of those included student exposure of longer than 10 days. At the junior high school level and below, there is relatively greater emphasis on the shorter-term efforts which dealt directly with students for periods ranging from an hour or two up to 10 days. The types of approach attempted in these efforts ranged from a single visit to a science museum to programs which streamed participants in science activities over a period of two or more years. Other efforts included:

--utilization of older students as teachers/guides for younger students
--special field trips, tours, and projects added to other programs
--the addition of special science topics to regular classroom activities
--extra coursework/training during the summer
--special training of teachers to present science topics
--pairing off of participants with science or engineering researchers for hands-on experience with scientific endeavors.

For any intervention attempt, its impact, if all other education flow factors remain constant, can be expected to be strongest at the point where it occurs in the education process. A project which seeks to strengthen the science interest of high school students may well succeed at getting some extra proportion of participants to elect science-related subjects or even to remain in high school to the point of graduation. But that increase cannot be expected to be maintained among the proportion of high school graduates who continue on to higher education since factors other than

[45] Chapter 18, pp. 171-186.

students' interest become more dominant. The proportionate decrement at various points in the education process in the number of students headed toward science has been roughly accounted for in the Typical Education Flow Pattern diagrams presented in the previous section, and thus it is possible to estimate the relative cost per student at a given point in the flow which is equivalent in ultimate outcome to the cost at another point. For native American students, for example, about 1/6 of those who complete grade 10 eventually enter higher learning at a four-year institution. Therefore, an intervention attempt which works with students already committed to higher-level learning could theoretically spend six times as much per student and still be cost-equivalent to an effort at the junior high school level. (The above applied to direct attempts to influence student participation, but several projects have tried to influence students indirectly through the special training of teachers and counselors. It is not possible to estimate the cost-per-student of those efforts in the same manner because of the sequential contact with groups of students over many years.)

However, in addition to dollar cost considerations, the actual or potential "value" of a project depends on the relative impact of the techniques employed and that is the area where the experience of the nearly 100 AAAS projects examined remains virtually mute. Lack of an evaluation of a project's impact results in no ability to estimate the net gain in student science participation over other kinds of intervention techniques or over no intervention at all. Of the 10 NSF projects which were designed to test intervention strategies (i.e., excluding the Stanford University project), the effectiveness of six can be estimated roughly from project information. (Those estimates and other cost information for the projects are shown in Table 1.) Impact is dependent on two interrelated project elements: participant selection strategies, and the effectiveness of project programming. For example, the University of Massachusetts project selected its participants according to strict criteria of quality and was very successful in its attempts to interest them in an engineering curriculum. Twenty-seven of the 37 participants entered engineering schools following high school completion, whereas only two or three had had pre-project plans to do so. An effectiveness of 50% was ascribed to the project to allow for possible future dropouts. For this project, the potential cost per student (calculated by estimating the number of additional students who could have been accommodated in the program without increasing program costs of $325.00, coupled with the project's great effectiveness, makes the technique very attractive when compared with other high school intervention strategies carried out at Colorado State University and UCLA no matter how effective they may prove to be.

Conversely, the University of North Dakota project programming seemed overly ambitious even for the qualified participants it had hoped to get. The number of hours of class contact and the number of different courses presented were both higher than those programmed at Olive-Harvey College where the target population was expected to be considerably better prepared to understand the material. The six-fold advantage in cost/effectiveness of the Olive-Harvey approach over the approach of the University of North Dakota suggests that the latter may be inappropriate at the pre-college level since the need to make up extraordinary anticipated differences among the targeted participant population is a direct contributor to North Dakota's potential cost-per-student.

Comparison of Costs-Per-Student for the NSF-Sponsored Minority Science Projects

	Administrative Costs	Participants Actual	Participants Potential	Cost/ Student Actual	Cost/ Student Potential	Effectiveness
Texas A. & I. University (teacher training)	$22,535	450 (18 teachers x 25 students each)	2500[4] (25 x 25 students x 4 yrs.)	$50	$9	10%
Michigan State University (science career incentives)	$ 44,992	?	?	?	?	?
UCLA (improved science contact)	$141,764	80	120	$1,775	$1,180	--
Colorado State University (counseling)	$158,800	150	150[6]	$1,060	$1,060	--
Temple University (engineering contact)	$ 55,286	30	120	$1,845	$ 460	--
Los Angeles County (counselor training)	$ 50,635	3,400 (17 counselors x 200 counselees)	7,200[4] (36 x 200 students x 4 yrs.)	$ 15	$ 2	5
University of Michigan (chemistry mini-course)	$ 21,242	70	135	$ 305	$ 160	20
University of North Dakota (pre-engineering training)	$ 29,623	13	20	$2,280	$1,480	10
Olive-Harvey College (pre-engineering training)	$ 48,300	43	100	$1,125	$ 485	20
University of Massachusetts (qualify for engineering)	$ 48,875	37	150	$1,320	$ 325	50

Notes:
1. Total grant award minus one-time start-up costs.
2. Estimate of the number of participants who could be accommodated without appreciable increase in project costs.
3. In terms of proportion of students whose science-related behavior is materially changed. This is a subjective figure based on project-collected data, AIR's observations, characteristics of the target population, and other information.
4. Arbitrary projection of four years of teacher/counselor contact with successive groups of students takes into account a probable decline in effectiveness over time and dilution by reassignment and resignation.
5. Project ongoing; no estimate of effectiveness possible at this time.
6. CSU project objective was to maximize the number of students per staff member during the experimental program.

For most of the NSF projects, and for a few of the other projects tabulated by AAAS, a general idea can be gained of the effectiveness of the intervention strategy utilized, but for the overwhelming majority of recent minority science education intervention attempts, the absence of impact evaluation prevents knowledgeable decisions being made about their potentia utility.